DOCUMENT RESUME

ED 257 350 HE 018 379

TITLE	Toward a Competitiveness Agenda. Special Joint Session with Members of Congress. Highlights of the Winter Meeting of the Business-Higher Education Forum (Scottsdale, Arizona, January 24-26, 1985).
INSTITUTION	Business-Higher Education Forum, Washington, D.C.
PUB DATE	Jan 85
NOTE	41p.
AVAILABLE FROM	Business-Higher Education Forum, American Council on Education, One Dupont Circle, Suite 800, Washington, DC 20036 (Free).
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Competition; *Economic Climate; Engineering Education; Futures (of Society); Higher Education; *Policy Formation; *Research and Development; Retraining; *School Business Relationship; Science Equipment; *Technological Advancement; Technology Transfer; World Affairs
IDENTIFIERS	Blue Ribbon Commissions; *Business Higher Education Forum

ABSTRACT

The development of a technology policy for the future was discussed at the winter 1985 meeting of the Business-Higher Education Forum, which met with congressional groups such as the Northeast-Midwest Congressional Coalition and the Congressional Clearinghouse on the Future. These proceedings include summaries of roundtable discussions on the following topics: changes in the global economic environment, the transition from basic research to commercial application, investment in science and technology, capital investments in research and development (R&D) facilities and instrumentation, engineering education, and work retraining. Highlights of two speeches are presented: Harold L. Hodgkinson's address concerning the changing demographic trends facing both corporate executives and educators, and Daniel Yankelovich's discussion of the difficulty in reaching a consensus on the nature of America's competitiveness problem and the best means of solving it. A plenary session covered key issues in R&D, technology, and education, and a panel session identified recommendations from the President's Commission on Industrial Competitiveness. Finally, two upcoming Forum reports on business schools and export controls were described. A list of meeting participants is included. (SW)

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TOWARD A COMPETITIVENESS AGENDA

Special Joint Session with Members of Congress

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Highlights of the 1985 Winter Meeting of the Business-Higher Education Forum

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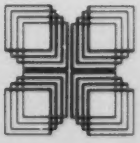
ACKNOWLEDGMENTS

The Business-Higher Education Forum wishes to acknowledge the invaluable assistance of the staff of the Northeast-Midwest Congressional Coalition in organizing the joint meeting between the Business-Higher Education Forum and members of Congress.

In addition, the production and distribution of these *Highlights* were made possible by contributions from Consolidated Natural Gas Company, Rockwell International Corporation and the Teachers Insurance and Annuity Association of America. Their support is greatly appreciated.

TOWARD A COMPETITIVENESS AGENDA

Special Joint Session with Members of Congress



Highlights of the 1985 Winter Meeting of the Business-Higher Education Forum

Camelback Inn Resort
Scottsdale, Arizona
January 24-26, 1985

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May 1985

CHAIRMAN'S REMARKS

I don't believe I am overstating the case in saying that our Winter meeting at the Camelback Inn Resort in Scottsdale was the most significant in the Forum's seven-year history. The Forum joined formally with members of Congressional groups such as the Northeast-Midwest Congressional Coalition and the Congressional Clearinghouse on the Future to pursue a common cause: in our case, the development of a rational, far-sighted science and technology policy for the next decade and beyond.

The discussions were provocative, timely and wide-ranging, covering such important topics as engineering education, worker retraining, America's deteriorating R&D infrastructure and the barriers to translating basic research into competitive products and processes.

We did not solve the multiple problems relating to the contribution of science and technology to American industrial competitiveness. But the Scottsdale meeting was an important start. We educators, business executives and Congressional leaders began the dialogue. Just as important, we intend to pursue that dialogue in a series of follow-up meetings throughout the coming year around the country. Our schedule of four regional meetings can be found in the "Next Steps" section of this report, on page 2-3.

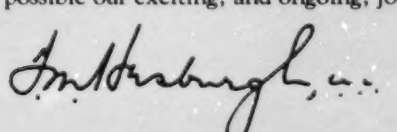
This edition of *Highlights*, then, is a report on our progress. It deals primarily with the Special Joint Session with members of Congress, particularly with the five concurrent round tables on the specific science and technology issues upon which we have agreed to focus our attention.

Although the centerpiece of the Scottsdale meeting was the Special Joint Session, our conference productively covered a number of other often related topics, too. Dr. Harold L. Hodgkinson delivered a provocative talk on the changing demographics facing both corporate executives and educators. NASA Administrator James Beggs provided a visionary look at the future of space exploration. We received a preview of the important work of the President's Commission on Industrial Competitiveness and timely updates on the upcoming Forum reports on business education and export controls.

Edward Donley, Chairman of Air Products and Chemicals, Inc., was elected chairman-elect of the Forum. He will take office in January 1986. Thornton F. Bradshaw, Chairman of RCA Corporation, and W.F. Kieschnick, President and Chief Executive Officer of Atlantic Richfield Company, were elected to the Forum executive committee. And finally, Representative Mo Udall and Columnist Art Buchwald lived up to their reputations as two of America's most engaging speakers.

This report on our proceedings also covers these other contributions. Unfortunately, neither the nature of this document nor its length permits us to do them justice.

Finally, I would like to express the gratitude of all members of the Forum to Representative Bob Edgar (Democrat-Pennsylvania) and Ruben F. Mettler, Chairman, TRW Inc., whose energetic leadership as co-chairmen of the Congressional/Business-Higher Education Forum Steering Committee made possible our exciting, and ongoing, joint initiative.



(Rev.) Theodore M. Hesburgh, C.S.C.
Forum Chairman
President, University of Notre Dame

THE NEXT STEPS

As part of their ongoing joint initiative to develop a public policy agenda that enhances American competitiveness, the Forum, the Northeast-Midwest Congressional Coalition and the Congressional Clearinghouse on the Future have scheduled four regional meetings this fall, to be followed by a national conference in or near Washington, D.C., on April 18-21, 1986. The purpose of the meetings is to expand the broad Scottsdale discussion topics into evening and morning sessions, which would focus on particular aspects of the problems and develop agreed-upon solutions and specific action plans.

A schedule of the upcoming regional meetings follows:

ISSUES FOR HIGHER EDUCATION

Site:	Cambridge, Massachusetts
Dates:	September 12-13
Host:	David Saxon (Chairman, The Corporation of the Massachusetts Institute of Technology)
Co-Sponsors:	Edward Donley (Chairman, Air Products and Chemicals, Inc.)
	Representative Claudine Schneider (Republican-Rhode Island)
Topics:	Training advanced technical personnel; faculty salaries; investment in state-of-the-art instrumentation and facilities.

STRENGTHENING U.S. COMPETITIVENESS IN GLOBAL MARKETS

Site:	Pittsburgh, Pennsylvania
Dates:	October 3-4
Host:	Douglas Danforth (Chairman and CEO, Westinghouse Electric Corporation)
Co-Sponsors:	Representative Bob Edgar (Democrat-Pennsylvania)
	Frank Rhodes (President, Cornell University)
Topics:	Trade policy; investment policy; intellectual property rights.

PREPARING THE WORK FORCE OF THE FUTURE

Site:	Palo Alto, California
Dates:	October 13-14
Host:	Donald Kennedy (President, Stanford University)
Co-Sponsors:	Albert Bowers (Chairman and Chief Executive Officer, Syntex Corporation)
	Representative Ed Zschau (Republican-California)
Topics:	Retraining the work force; ITAs; block investment credits; unemployment compensation.

LONG-TERM U.S. SCIENCE AND TECHNOLOGY POLICY

Site:	Orlando, Florida
Dates:	November 14-15
Hosts:	Representative Buddy MacKay (Democrat-Florida)
	Representative Bill Nelson (Democrat-Florida)
Co-Sponsors:	William Friday (President, University of North Carolina)
	Ruben Mettler (Chairman of the Board, TRW Inc.)
Topics:	Balancing civilian and defense R&D; basic R&D; internationalizing "big science"; improving data collection from overseas.

Rep. Robert W. Edgar (D-Pennsylvania)

WELCOMING REMARKS

The Special Joint Session with Members of Congress formally opened with welcoming remarks by Representative Bob Edgar (Democrat-Pennsylvania) and Ruben Mettler (Chairman, TRW Inc.), co-chairmen of the Congressional/Business-Higher Education Forum Steering Committee. "We don't view this meeting as a one-time shot," said Edgar, pointing to the expectation that the ongoing relationship between Congress and the Forum will lead to the preparation of a joint report on the issues of science, technology, research and development, which "will lay out the components of an action agenda."

Similarly, after noting that many manifestations and causes of America's declining competitiveness are already well-known, Mettler challenged participants to focus their efforts. "I suggest we identify and seek out points of agreement — where both the need for action and the potential for action are clear. From the work previously done, from our discussions here, and through a continuing effort, I am confident we will find much that we can do together, if we learn to work effectively with each other," he said.

Daniel Yankelovich (Yankelovich, Skelly & White)

YANKELOVICH DISCUSSES "THE ELUSIVE CONSENSUS"

Daniel Yankelovich (Chairman, Yankelovich, Skelly and White, Inc.) fittingly placed the issues in context by zeroing in on the central dilemma that participants would confront throughout the Scottsdale meeting: the difficulty in reaching a consensus on the nature of America's competitiveness problem and the best means of solving it.

In his luncheon speech, Yankelovich suggested the first step toward consensus-building must be to eliminate obstacles, chief of which is a lack of sharp focus on the underlying causes of declining U.S. economic competitiveness. Among the many possible explanations often cited include adversarial relationships between businessmen and government and between management and labor, short-term focus, erosion of the work ethic, consumption over savings, and the production of less than top-quality goods. "The problem is whenever you have multiple explanations for a phenomenon, there's a difficulty in mobilizing a consensus," Yankelovich said. "When you have too many explanations, in effect you have none."

Other obstacles include an inability to integrate short-term solutions into long-term responses, a societal split about the proper role of government, and a "diversionary kind of logic," epitomized by the debate over the dollar's role in competitiveness. Federal deficits understandably help create an overvalued dollar, which in turn stifles U.S. exports. But to leap to the conclusion — as many do — that reducing federal deficits and the dollar's value will somehow magically restore America's global competitiveness is at worst incorrect, at best imprudent, Yankelovich said.

Even if the obstacles are eliminated, building a consensus still requires "a powerful, political story," Yankelovich stated, "an explanation of what is happening and why, which meets certain criteria that people have." The story must touch a raw nerve, make intuitive sense and be capable of solution. Short of a precipitating event, such as Sputnik, Yankelovich predicted it will take the United States "a couple of years" to agree on a compelling "story," to "tease out the enormous complexity of this problem."

Yankelovich concluded by reciting his own version of the "competi-

tiveness story," which meets his three criteria: "The key to restoring our competitive vitality is doing a better job in managing the people/technology relationship so that people don't feel that their jobs are threatened by technology. They must feel a positive incentive to upgrade their jobs, to improve themselves by using the technology to optimum effectiveness. And we must find more powerful uses and more direct links forged between commercial applications in world markets and our R&D in the management of that kind of technology. If distilled and worked over, it has the ingredients of a single story. It may not be the right one, but at least it gets the process going and challenges a group like this to refine other possible explanations until they are forged into a single one."

PLENARY SESSION: KEY ISSUES IN R&D, TECHNOLOGY AND EDUCATION

The centerpiece of the Special Joint Session with Members of Congress — the five concurrent round tables on specific issues — was preceded by an introductory session for all participants. The session was moderated by Representative Buddy MacKay (Democrat-Florida and co-chair, Research and Development Task Force, Congressional Clearinghouse on the Future) and Douglas Danforth (Chairman and CEO, Westinghouse Electric Corporation), with significant contributions from Donald Kennedy (President, Stanford University) and Representative Don Fuqua (Democrat-Florida and Chairman of the House Committee on Science and Technology).

MacKay opened the session by praising the Forum's efforts in bringing together business, academic and government leaders to discuss these vital areas of mutual concern. "You've recognized earlier than anyone else that the real need in this country is not for a new government program, but for a mechanism for creating consensus with decentralized leadership," he said, calling for an end to the adversarial relationships that permeate society, but which "are no longer functional."

Westinghouse's Danforth turned the attention of the group to several key issues in research. "The future vitality of our economic base depends upon how skillful we are in programming, developing and managing our scientific and technological programs," he said. "We're no longer an isolated nation of 250 million people. We're really competing with many major countries and certainly with many emerging countries, so that what we develop must be indeed international in nature and not just for use within our borders," he said. Within that context, Americans must recognize that many commodity-type products will be manufactured abroad, and that the U.S. private sector must pick the areas in which it wants to compete — and then do so vigorously.

In basic research, the key challenge is to make better use of available funds, Danforth said, observing that it is "unrealistic" to expect additional federal monies soon. Improved collaboration among researchers and institutions should be encouraged, through such mechanisms as relaxation of the antitrust laws as well as constant and extended exchanges of personnel from the private sector to the public sector, and vice versa.

Focusing on the antiquated research facilities and equipment with which colleges and universities must cope, Stanford's Kennedy agreed with Danforth that federal funding is unlikely to increase significantly, at least in

Philip Caldwell (Ford Motor Company) addresses plenary session

the short term. Because the federal budget has not contained a specific line item for research facilities since 1968 and because the private sector has been unable to make up the difference, there is today an estimated shortfall in excess of $2 billion just for equipment used to conduct basic scientific research, Kennedy estimated.

That shortfall underscores the wide disparity between the nation's research requirements and the capital infrastructure in place to support them. There are two principal negative consequences of that gap, Kennedy said. First, the funding of basic research increasingly is being done on an ad-hoc, uncoordinated basis, frequently through last-minute amendments to legislation instead of through the more deliberative agency-by-agency process of peer review and scientific evaluation of projects. Second, the decline in government-supplied research equipment and facilities means that university administrators have been forced to transfer capital expenditures to their operating budgets, where they are the first to be cut in times of fiscal stringency.

Kennedy saw one silver lining in the cloud hovering over basic research, however: the increasing collaboration between industry and research universities, marked by creative institution-building and the development of new sources of support. But such partnerships, however innovative, cannot fully "produce the kind of help for fundamental university research that is needed," he said.

Finally, Representative Fuqua focused on the evolving partnerships into which the United States is entering with Japan and Western European nations. While such arrangements might mean the United States must sacrifice some of its nationalism, international collaboration increasingly is needed to finance major research initiatives, such as the space station, he said.

Fuqua concluded by reporting that his House Committee on Science and Technology has begun a major two-year study on the proper federal role in science over the next 40 years.

ROUND TABLE I: CHANGES IN THE GLOBAL ECONOMIC ENVIRONMENT

Conveners: Philip Caldwell, Chairman, Ford Motor Company
Representative Don Ritter (Republican-Pennsylvania)

Resource Person: Pat Choate, TRW Inc.

THE ISSUE

The increasing internationalization of the economy significantly alters the environment in which R&D is conducted and puts more pressure on nations both to export and to protect their scientific and technological resources. Technology is becoming ever more important as a trade commodity, indispensable to U.S. economic competitiveness, yet difficult to protect.

Quick-paced technological progress creates many formidable challenges, but two are pivotal: (1) overcoming the myriad barriers that prevent U.S. businesses from deploying American technology worldwide; and (2) halting the erosion of U.S. intellectual property rights. The nation's success in addressing these issues will ultimately define its long-term competitiveness.

THE ROLE OF TECHNOLOGY

The primary focus of these two round tables was the need for the United States to strengthen its competitiveness in the global marketplace. Special attention was given to the role of U.S. technology in achieving that goal.

The first issue addressed by both workshops was whether or not the United States has a competitiveness problem. Phil Caldwell pointed out that since 1980 the United States has gone from a surplus of $19 billion in manufactured goods to a deficit of $80 billion. He also noted that the economic environment for American-produced goods has deteriorated during that time.

This deterioration started with a few products such as radios, televisions, shoes and soft goods, then moved to autos and steel, and now has spread to every key manufacturing sector — machine tools, machinery and equipment, and electronics and chips.

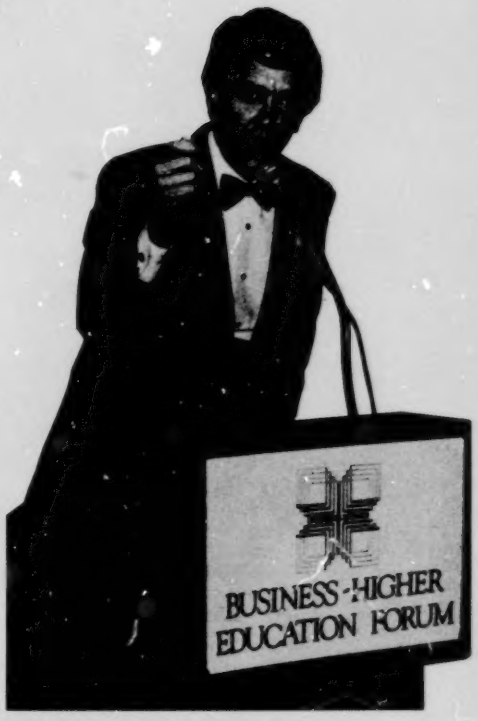
The weakness in the competitiveness of U.S. manufactured products can be traced to several factors:

- U.S. exports have been adversely affected by both the rapid U.S. economic recovery and the sharp reduction in imports by the less developed nations, which are struggling with their own debt problems.
- The relative slippage of the United States from its unchallenged, dominant position in the global market.
- The rise of strong economic competitors — notably Japan and other nations from the Pacific Rim, with their compatible governmental and private sector policies and practices — has made obsolete and uncompetitive many American practices which divide rather than focus the combined potential of the private sector and government.

The round tables identified several manifestations of how inattention to the consequences of ad hoc and uncoordinated decisions by government and business are adversely affecting U.S. trade competitiveness. Among the most important of these consequences has been the appreciation of the dollar more than 30 percent against a trade-weighted index of the currencies used by the United States' major trading partners. The strong dollar provides an unearned subsidy for foreign producers and is an almost insurmountable competitiveness barrier for most American exporters.

Both groups concluded that reducing the federal deficit, and hence the inflated value of the dollar, is necessary, but that it is not enough to improve long-term U.S. trade competitiveness. Rather, round table participants agreed that a number of actions would be required by all parts of our society to help America compete. Industry must improve its efficiency, undertake better research, better utilize its technologies, invest in modern capital facilities and introduce more competitive work practices. The education system — from secondary education to the universities — must introduce more competitive educational practices, too, by insisting on higher-quality standards and by graduating more students skilled in critical areas. And government must be competitive as well — that is, it must realize its major role in establishing the environment for U.S. economic competitiveness in the global marketplace and explicitly consider its actions in that context.

Discussants agreed that technology is a premier U.S. competitive advantage in the global marketplace. Because other nations have less expensive labor and because capital is mobile, America's ability to create and apply technology is essential to maintaining its competitive edge. Partici-



Arizona Governor Bruce Babbitt

pants also agreed, however, that better application of American technology requires:

- Greatly strengthened protection of U.S. intellectual property rights in the global economy. The existing system of safeguards is so weak as to be almost worthless, participants said. Consequently, firms of other nations, often in cooperation with their governments, are appropriating U.S. technology with little or no compensation to its owners.
- A more realistic application of U.S. laws. Many domestic laws, such as antitrust provisions governing the operation of U.S. overseas affiliates, retard the creation and application of American technologies.
- An American trade policy. A profusion of trade and investment barriers have been created in other nations that retard the sales of U.S. products, even when those goods are superior in terms of price, quality, service and innovation. The United States lacks, but badly needs, a coherent, aggressive trade policy that will open foreign markets, even as U.S. markets are opened to foreign firms.
- New research mechanisms. Foreign research consortiums, particularly in Japan, are closed to U.S. scholars and firms, while U.S. research is open to foreign firms. Over the longer term, this disparity is sure to place the United States at a disadvantage.

George H. Dixon (First Bank System, Inc.) and Rep. Doug Walgren (D-Pennsylvania)

Workshop participants concluded that U.S. economic interests in the global marketplace are given secondary consideration, after defense and foreign policy concerns; economic issues often are not considered at all. The participants also observed the view that other nations better perceive the connections among economic, defense and foreign policy considerations and proceed accordingly with comprehensive policies.

The workshops concluded that the United States requires a broad-based political and public consensus that competitiveness must be a primary national objective. The nation also requires a competitiveness strategy involving all segments of society. In this strategy, the effects of government actions on U.S. competitiveness must be measured prior to their implementation. Also, the nation must continue to promote the ideal of freer trade, but must be willing to use access to U.S. markets as a means of securing reciprocal rights to foreign markets.

While workshop participants were not unanimous in their assessment of all elements that must comprise a total agenda for strengthening long-term U.S. competitiveness, they did find many areas of agreement, notably in the areas addressed above. Moreover, they agreed that it is in the national interest to continue to identify areas of agreement and then to take action. That goal will be the focus of continuing work of the Congressional/Business-Higher Education Forum initiative.

ROUND TABLE II:
THE TRANSITION FROM BASIC RESEARCH TO COMMERCIAL APPLICATION

Conveners: Albert Bowers, Chairman and Chief Executive Officer, Syntex Corporation
Bobby Inman, Chairman, Microelectronics and Computer Technology Corporation

Resource Person: Denis J. Prager, MacArthur Foundation

THE ISSUE

The decline in the competitiveness of American industry on world markets is a serious reality. It jeopardizes the nation's prestige and security, its economic strength and stability, and the quality of life of its citizens.

The ability of the United States to retain its leadership position in international economic development depends largely on its capacity to develop and apply technology efficiently. There is widespread agreement that, when compared with its principal economic competitors, the United States is relatively inefficien. in translating new knowledge, concepts and technologies into commercially competitive products.

TWO APPROACHES TO COMMERCIALIZATION

An underlying and recurring theme of the round tables involved comparing the United States and Japan in terms of the environments within which the development and commercialization of new technologies occur. The relative competitiveness of the two countries directly reflects their starkly contrasting approaches to international economic competition, which, in turn, reflect their starkly contrasting cultures and social structures.

The Commitment Gap. *Japan* has resolved to become, economically, the strongest nation on earth, making the national and personal sacrifices and compromises necessary to make that goal a reality. The *United States* has yet to recognize the full significance and seriousness of declining international economic competitiveness and to resolve to implement the actions and make the sacrifices and compromises necessary to retain and sustain our international technological leadership.

The Environment for Innovation. *Japan* has taken the steps necessary to establish a legal, regulatory, financial and social environment highly conducive to the efficient development and commercialization of technology. In the *United States*, there remain many legal, regulatory, financial and social barriers, which constitute substantial obstacles to the efficient translation of new concepts and technologies into commercially competitive products and processes.

Mobilizing Resources. *Japan* has taken the steps necessary to organize and mobilize into a highly effective team ("Japan Inc.") the national resources — government, industry, labor, banking, higher education — required to achieve its ambitious economic goals. In the *United States*, the different sectors often view each other as adversaries, making it extremely difficult to mobilize the broad array of complementary and interdependent resources required for sustained international technological competitiveness.

Targeting. *Japan's* strategy for achieving its economic goals involves targeting market sectors, establishing specific market-share goals, setting

stringent timetables and inhibiting access to Japanese domestic markets by foreign competitive industries. In the *United States*, the development of specific national strategies for enhancing industrial competitiveness is viewed as antithetical to the "free enterprise" system.

Corporate Time Horizons. *Japan* adheres tenaciously to a long-term perspective, eschewing immediate expedients and profits for the expected benefits of a long-range strategy. In the *United States*, corporate decision-making is influenced predominantly by the perceived demand for short-term profitability.

Basic Research vs. Technology Development. *Japan* has accelerated its ascent to world economic leadership by concentrating on the development and commercialization of new technologies, rather than on research, and by commercializing technologies acquired from other countries. In the *United States*, there is an explicit national policy of public sector support for basic science, with the development and commercialization of new technology seen as principally the responsibility of the private sector. The resulting largely artificial dichotomy between basic research and technology development constitutes a major barrier to the efficient translation of new knowledge to commercial products. In addition, we lack mechanisms for identifying and acquiring technologies invented abroad for commercialization here.

THE NEED FOR FACTS

The above comparisons help describe the factors contributing to the growing discrepancy between the industrial competitiveness of the United States and its principal economic rival. However, these generalities tend to mask underlying differences and gradations among various industries, technologies and sectors, which may provide useful insights into restoring America's competitive edge.

Participants pointed out that successful strategies to restore American competitiveness must be based on objective analysis of the facts concerning the relative success of domestic and foreign industries on international markets and the relative impacts of the policies and practices of governments, business and higher education. The facts for such an analysis are difficult to ascertain, but a concerted effort to collect and analyze such data must be a high priority for those concerned with the formulation of effective competitiveness strategies.

It is critical that the United States eschew defensiveness and paranoia, opting for reasoned and objective analyses of our comparative strengths and weaknesses, successes and failures. For instance, some American industries translate research to commercial application very efficiently, collaborate closely with university scientists, manage with a long-term view, and/or develop effective means of penetrating foreign markets; others don't. Some universities facilitate the translation process by developing innovative research and training programs and actively pursuing partnerships with industries; others don't. Some government policies and practices facilitate efforts by industry to compete internationally; others constitute real roadblocks.

DEVELOPING HUMAN RESOURCES

The participants in the round tables discussed two elements felt to be among those critical to efforts to enhance the translation of research results

into commercially competitive products: adequate human resources and obstacles to innovation.

In order to translate efficiently emerging technologies into commercially competitive products, the United States needs adequate numbers of appropriately trained scientists and engineers. This means optimum use of the existing pool of talent, as well as the ongoing development of new scientists and engineers capable of coping with rapid technological advancement.

The quality and quantity of America's future work force are in jeopardy. The principal source of concern is the increasing inability of higher education to attract adequate numbers of American graduate students to meet industrial demand for highly trained scientists and engineers and university demand for academic faculty. The current high percentage of foreign graduate students and young faculty in engineering schools is principally due to the vacuum created by the scarcity of American graduates willing to forgo or postpone lucrative industrial careers. Reasons for this situation include:

(1) Cutbacks in graduate student fellowships;

(2) A critical and worsening engineering faculty shortage, due primarily to the growing industrial demand for technologists and the concomitant attractive salaries and environment offered them; and

(3) A decline in the research environment at universities, reflecting growing obsolescence of research equipment and facilities, scarcer federal research funds and the inflexibility of the traditional higher education mentality.

Participants agreed that meeting future needs of government, industry and higher education for adequate numbers of suitably trained American scientists and engineers will require the following sectors to develop and implement innovative policies and programs intended to create and sustain appropriate educational opportunities, environments and incentives.

(1) *Universities* must institute flexible and responsive programs and policies intended to make graduate technical education and academic careers more attractive, by:
- Making the content of graduate education more responsive to private sector needs;
- Designing flexible graduate education programs which are attractive to students beyond the traditional 18-24 age range and accessible at various levels of professional achievement; and
- Establishing relationships with neighboring industries, which (a) make it feasible and attractive for industrial scientists and engineers to serve as part-time faculty members, (b) permit university faculty to work part-time in industry, (c) create opportunities for graduate students to work in industry while pursuing advanced degrees, (d) encourage graduate students to pursue dissertation research based in industry, and (e) use industrial resources to update obsolete teaching and research equipment and facilities and to stabilize the research support base.

(2) *Industry* must increasingly recognize its responsibility for helping train the students on which its future depends, by:
- Working with the higher education community to develop

Rep. Bob Carr (D-Michigan) and Harold T. Shapiro (The University of Michigan)

Rep. Robert W. Edgar (D-Pennsylvania); Douglas D. Danforth (Westinghouse Electric Corporation); Rep. Buddy MacKay (D-Florida); Donald Kennedy (Stanford University); Rev. Theodore M. Hesburgh, C.S.C. (University of Notre Dame); and Rep. Don Fuqua (D-Florida)

training programs and curricula designed to produce graduates suitable for industrial careers;

- Providing resources intended to help universities maintain state-of-the-art equipment and facilities and research and teaching environments; and
- Instituting policies and programs which (a) permit and encourage industry scientists and engineers to teach part-time in nearby universities and university faculty to work part-time in industry, and (b) create opportunities for university graduate students to work in industry while pursuing advanced degrees and for industry employees to pursue advanced degrees while working.

(3) *State governments* can, and must, play an increasing role in assuring an adequate and sustained supply of suitably trained scientists and engineers, by:

- Increasing the quality of the state public education system at all levels;
- Establishing competitive scholarship and fellowship programs intended to make graduate programs in the sciences and engineering more attractive; and
- Making university teaching and research more attractive by (a) increasing faculty salaries, (b) permitting faculty to work part-time in industry, and (c) enhancing the research and teaching environments in state universities so as to increase the degree to which those institutions can compete successfully for federal and industrial research funds.

(4) The *federal government* can, and must, take steps to assure that the nation is able to meet its future needs for trained scientists and engineers, by:

- Working with state and local school authorities to increase the quality of elementary and secondary education throughout the country;
- Increasing the number and level of fellowships available for graduate education in the sciences and engineering;
- Helping universities sustain high quality, state-of-the-art equipment and facilities for research and teaching; and
- Creating incentives intended to stimulate industrial support of graduate research and education.

THE INNOVATION PROCESS: REDUCING THE BARRIERS

The round table participants agreed that the United States does not maintain an environment conducive to the efficient development and commercialization of new technology. In fact, the legal, regulatory, financial and social environment within which technological innovation takes place impedes the translation of new concepts and technologies into commercially competitive products. Among the approaches discussed for reducing the obstacles to commercialization were the following:

(1) Change the "*corporate culture*" to one which:

- Takes a long-term view of bottom-line profitability and the ultimate wisdom in, and payoffs from, major investments in corporate research, technological innovation and capital improvements to research and production facilities;
- Increases the involvement of labor in discussions of ways to increase competitiveness, and provides real incentives for product and process innovations by employees;
- Places greater emphasis on innovation in manufacturing technology;
- Recognizes the increasingly international nature of markets by (a) taking culture into account in the design of products intended for export, (b) training marketing and technical assistance work forces in the languages and cultural practices of foreign societies, (c) driving harder bargains in licensing technologies to foreign competitors, and (d) establishing foreign intelligence networks capable of identifying foreign technologies appropriate for licensing and commercialization by U.S. companies;
- Creates innovative relationships with universities in order to (a) stimulate and sustain university research and educational functions, (b) benefit from university research and training, and (c) facilitate the rapid translation of research results to commercial applications;
- Creates innovative relationships among companies with common research, innovation and educational needs; and
- Works as a partner with the legislative and executive branches of both federal and state governments to promote policies conducive to competitiveness.

(2) Establish the principal role of the *federal government* in the arena of competitiveness as striving, to the degree consistent with other societal imperatives, to improve the environment for technological innovation and industrial competitiveness, by:

- Assuming primary responsibility for the support of basic science, the training of future scientists and the health of America's basic science infrastructure;
- Focusing on establishing and sustaining access to foreign markets by U.S. companies, rather than on artificially protecting U.S. markets against foreign competitors;
- Providing and *sustaining* tax and other incentives to help stimulate (a) the establishment of small companies to commercialize emerging technologies, and (b) increased industry investment in R&D, in university research and training, in long-term capital modernization and expansion, and in manufacturing technology;
- Recognizing the federal procurement process as potentially the most powerful public sector influence on competitiveness, and completely restructuring and reorienting that process so that it (a) incorporates substantial incentives for efficiency and timeliness, (b) incorporates substantial penalties for unnecessary technological sophistication and delays, (c) rewards innovation, and (d) eliminates the need for the huge bu-

Jack D. Sparks (Whirlpool Corporation); Rep. Nancy L. Johnson (R-Connecticut); William C. Friday (University of North Carolina); and Clifton R. Wharton, Jr. (State University of New York System)

reaucracies — in both the public and private sectors — required to oversee and certify the present process;

- Instituting incentives for private sector commercialization of inventions resulting from research conducted or supported by the federal government;
- Continuing to modify antitrust laws and policies to better reflect the realities of a marketplace increasingly characterized by international competition; and
- Continuing to include, in the assessment of the costs and benefits of environmental, health and safety regulations, analyses of the impacts of various degrees of regulation on the international competitiveness of the affected industries.

(3) Increasing the role of *state governments* in improving the intrastate environment for technological innovation and industrial competitiveness.

(4) Looking increasingly to *institutions of higher learning* for innovations in administration, human resource development and utilization, and inter-institutional relationships as means of assuring that these institutions sustain their critical role in science and engineering research and training.

A CALL TO ACTION

Robert Anderson (Rockwell International Corporation); Alan H. Magazine (Business-Higher Education Forum); James Beggs (National Aeronautics and Space Administration); and Charles E. Young (University of California, Los Angeles)

The discussions were characterized by a certain sense of frustration and impatience. This sense was best expressed by one participant when he said, "We know what to do, let's get on with it." So, why don't we "get on with it?" The answer seems to be an inability (a) to reach a national consensus on the importance of restoring American competitiveness, and (b) to make a commitment to that goal.

Recognizing these obstacles, the round table participants formulated a "call to action," which embraces Daniel Yankelovich's articulation of the prerequisites to progress: first, develop a national consensus on the need for a concerted effort to restore America's international competitiveness; second, translate that consensus into commitment by making the necessary individual sacrifices and societal compromises; third, mobilize jointly the human, financial and institutional resources — both public and private — necessary to achieve the goal of increased competitiveness; and, finally, translate that commitment into cooperative action.

ROUND TABLE III: INVESTMENT IN SCIENCE AND TECHNOLOGY

Conveners: Representative Buddy MacKay (Democrat-Florida)
Charles E. Young, Chancellor, University of California, Los Angeles

Resource Person: Christopher T. Hill, Congressional Research Service

THE ISSUE

Preserving the standard of living, quality of life and security of the United States requires a continuous investment in science and technology —

both on basic research and on the quick, effective and wise transformation of that technology into useful products and processes.

There is growing evidence that key aspects of America's development and wise use of new science and technology are declining. The mathematical and scientific understanding of both educated elites and the general public is low. The amount of national R&D spending allocated to defense is rising rapidly (70 percent of total federal R&D spending), while the direct spin-off of technology from defense to the civilian sector appears to be decreasing.

There is also less attention paid to managing the undesirable consequences of the use of technology, a decline due perhaps to the fact that the impacts of the newer "high technologies" are less obvious than the effects of the older "smokestack" technologies. In addition, technological advance has become increasingly sophisticated and dependent on scientific understanding, and it is now widely accepted that such sophistication and understanding must be more broadly distributed throughout society than it now is.

Four major issues are central to an examination of U.S. investment in science and technology: how much should the nation invest in science and technology; who should make the investments; how much should be spent on various aspects of science and technology; and should the established patterns of U.S. government and industry investment be changed, and if so, how?

FIRST SESSION

The group first reviewed some basic statistical information on R&D spending in the United States and overseas — in the government, industry and university sectors.

For instance, of the $97 billion spent on R&D in the United States in 1984, 51 percent of the funds came from industry, 46 percent from the federal government, 2 percent from colleges and universities, and 1 percent from other non-profit institutions. Two-thirds of those funds were spent for development, 22 percent on applied research and 12 percent on basic research. Industry performed three-quarters of the nation's R&D, followed by the federal government (11 percent) and colleges and universities (8 percent), although the latter perform 59 percent of the nation's basic research.

This review led directly to a discussion of national priorities for science and technology, especially as reflected in federal spending patterns. Considerable attention was paid to the relationship of federal defense R&D spending to the performance of the civilian economy. While intending no judgment on the wisdom of the current level of spending on defense R&D, concern was expressed that the growth in the fraction of federal R&D devoted to defense, from about 50 percent to nearly 70 percent during the last five years, is inconsistent with the perception that U.S. industrial technology development is lagging behind that of competing nations. Concern was also raised over whether the rapid growth in defense R&D might be diverting the nation's best young scientists and engineers away from basic research and civilian technology.

During a discussion of whether technology transfers from defense R&D to the civilian economy have declined, one participant observed that the amount of such transfers has never been very significant and that the most important contribution of defense R&D to non-military technology has been its support of basic research in universities. In this regard, there was general criticism of the "Mansfield Amendment" of 1968, which is believed to have

discouraged Department of Defense (DoD) support of basic research. Participants agreed that current initiatives to increase such support should be encouraged.

Recognizing that many faculty continue to prefer support from the National Science Foundation (NSF) or National Institutes of Health (NIH) over that of DoD, participants nonetheless noted that the attitudes of universities toward defense research have changed over the past decade, with the universities far more willing to accept such funds.

Several university representatives said that the official statistics on universities' own R&D spending substantially understate their contributions to the nation's R&D totals, because a great deal of university research support is implicit in faculty salaries, buildings, libraries and the like. Those programs are funded in part by endowment, gifts and tuition. While no data were presented, it was suggested that perhaps twice as much is spent by universities on R&D as is officially reported to NSF.

The overriding importance of federal support for graduate education in engineering and science was noted, as there is a continuing need for more such graduates. In addition, participants called for a new round of federal support, through NSF, for redesign of the curricula and development of new text materials for teaching math and science at the secondary school level. Such programs were both extensive and successful in the post-Sputnik era, and provide a good model for today's requirements, it was argued.

Rep. Bob Traxler (D-Michigan) and Robert Anderson (Rockwell International Corporation)

While a growing proportion of science and engineering graduate students in the United States are not American citizens, the access of those students to U.S. university laboratories is increasingly limited by government restraints imposed in the name of national security. While some viewed the growing numbers of foreign nationals with alarm, others observed that foreign enrollment is a sign of the strength of the U.S. system of higher education as seen from abroad. In addition, helping to educate the world is an appropriate role for a wealthy country such as the United States. It was also pointed out that the flow of such students to the United States, especially when they elect to stay here after they finish their education, can be viewed as a kind of foreign aid to America. For example, Lerner and Roy have estimated that immigration of scientists, engineers and physicians from the Third World is equivalent to a subsidy to the United States of between $1.2 billion and $8.6 billion per year.

The round table briefly discussed the federal role in applied research and industrial R&D. Some suggested that the government focus its participation on applied research in areas to improve defense and the quality of life, and that it pay less attention to applied research intended to enhance economic growth and competitiveness. Some even asked whether government support for applied research in the economic sphere made any significant contribution. One long-term observer of NSF spoke against support of applied research by that agency. Instead, NSF should focus its limited resources on basic research, and government assistance to applied research and industrial development should emphasize improving the climate for such activity.

Finally, the group turned its attention to the question of the effectiveness of federal R&D spending, suggesting that how the funds are spent is as important as the amount spent. More attention needs to be paid to the incentive structure within which individual researchers work, and to ensure that they enjoy both financial and non-financial recognition for good performance. It was pointed out that timing is the essence of technological competition, since competitors will always catch up at some point. Thus,

more needs to be done to ensure that U.S. firms and institutions can move quickly to take advantage of new opportunities to commercialize R&D results.

Participants observed that multiple sources of support for similar kinds of research help avoid the stultifying effects of orthodoxy. Along those lines, they criticized the proposal made by the President's Commission on Industrial Competitiveness for the creation of a Department of Science and Technology. Participants argued that "more efficient" management of federal R&D spending might lead to a decline in the availability of multiple funding sources.

SECOND SESSION

In contrast to the first session, which devoted a substantial portion of its time to issues involving university research, the second session focused on the federal roles in supporting R&D related to industrial competitiveness and in ensuring adequate access to foreign technology.

One participant suggested that "competitiveness" be adopted as a new, broad functional category of R&D activity, analogous to "defense." He further suggested that, rather than thinking of applied research and development as synonymous with competitiveness R&D, it would be better to conceptualize a portfolio of R&D efforts at each stage (basic, applied, development), which together would support competitiveness.

Some debate ensued on whether government can play a constructive role in supporting R&D related to competitiveness, other than through such indirect mechanisms as the R&D tax credit. It was argued that the government can only do a good job in this area when it is the intended customer for the target technology. The validity of this statement was challenged by one participant who is not convinced that the government record in military technology supports this view. On the other hand, there seemed to be agreement that there is a gray area of "generic applied research" to which government can constructively contribute, and that there is a need to support more such activity. With regard to mechanisms, one participant called for NSF to support more applied research, contradicting the view in the first session that NSF should not support applied research.

A suggestion was made for a federal program to provide seed funding (for example, through the NSF or the Department of Commerce) for establishing centers for applied research on specific technological areas. Such university-based centers would subsequently seek sustaining support from consortia of industrial firms. This proposal is based on the belief that one of the comparative strengths of the United States, vis-a-vis other countries, is the potential for cooperation among government, universities and industry, but that this advantage is not being fully exploited. The participants were not aware that the Stevenson-Wydler Technology Innovation Act of 1980 authorizes such programs in NSF and Commerce; some thought the existing law might offer a mechanism for accomplishing this goal. Others noted that joint corporate support of such centers raises the possibility of antitrust challenges as well as barriers to free publication and to participation by foreign students and foreign firms; they argued that such issues must be addressed early in the design of a program to avoid their becoming major problems at a later stage.

There was general agreement that the federal government could play a stronger role in ensuring access by U.S. firms to foreign technology. It was

Ruben F. Mettler (TRW Inc.)

suggested that more could be done in such areas as providing assistance to business in identifying foreign opportunities, negotiating licensing agreements overseas and providing "commercial intelligence." Some felt that U.S. commercial attaches could do more in this area, and that more such persons were needed. Others observed that the attaches are making the best of a difficult situation.

It was also suggested that more attention be paid to instruction in foreign languages, especially Japanese, and that more resources be devoted to timely translation of foreign language articles and books. Similarly, the group was urged to support continued funding for universities' foreign area studies, which have been proposed for elimination in the Administration's FY86 budget.

Finally, the session was challenged by the observation that the kinds of efforts under discussion at this meeting have little hope of being adopted, because there is no consensus in Washington about what actions might be either effective or appropriate. So long as both political parties are divided on these questions, making problematic both partisan initiatives and bipartisan cooperation, it is unlikely that any new program of government R&D support related to industrial technology will be adopted or funded.

Some observed that exceptions can arise when programs are tied into national defense, and their funding can be justified under that umbrella. But others observed that reduction of the defense budget is essential to making more funds available for the area of industrial competitiveness. Several participants observed that the Business-Higher Education Forum has an important opportunity to help develop the necessary consensus around the broad issue of competitiveness.

Rev. Theodore M. Hesburgh, C.S.C. (University of Notre Dame) and Edward Donley (Air Products and Chemicals, Inc.)

ROUND TABLE IV: CAPITAL INVESTMENTS IN R&D FACILITIES AND INSTRUMENTATION

Conveners: Marvin L. Goldberger, President, California Institute of Technology

Representative Doug Walgren (Democrat-Pennsylvania)

Resource Person: John C. Crowley, Association of American Universities

THE ISSUE

America's colleges and universities now face substantial, growing and unmet needs to replace obsolete research instrumentation and to modernize research laboratories. One-half of higher education's physical plant is more than 25 years old. One-quarter of it was constructed before World War II. Some analyses say the total nationwide price tag for replacement and renewal of university facilities, including research laboratories and instrumentation, is between $30-$40 billion.

The importance of university research to all other national goals should not be underestimated. Research universities conduct about 12 percent of the nation's total R&D and more than half of its basic research. Government at all levels, business and the entire U.S. educational enterprise all depend on the primary products (new knowledge and highly trained scientists and engineers) and the by-products (consulting expertise) of university laborato-

ries. These laboratories are essential to national, regional, state and local objectives in defense, health care, technological development, economic productivity, energy, environmental control and education. New ideas, new processes and products, new technologies and often new industries emerge from the fertile interactions that occur among university researchers, their graduate students and those who work with them. Therefore, facilities deficiencies which impede research and training programs undermine not just the functioning of universities but the missions and interests of other important sectors as well.

AREAS OF AGREEMENT

Several propositions were readily accepted and reaffirmed by the round table participants. They can be restated briefly. *First,* the United States is fundamentally dependent upon its R&D enterprise. There is a direct link between the quality of research and development, on the one hand, and industrial productivity, security, health and general welfare, on the other. *Second,* industry needs the fruits of university basic research programs to provide the "take-off points" for new ventures. The nation's well-being depends upon the ability to generate new ideas and to put them to work in the global marketplace. *Third,* to sustain its research enterprise, talented graduate students and faculty must be attracted to, and retained in, the universities.

Fourth, the decision to couple the research and training functions in U.S. universities, made several decades ago, has great value, giving America an important marketplace advantage. To change the system now would require a whole set of cultural transformations. Rather, the requirement is to strengthen the linkages between research and training. The first step must be to examine whether the current mechanisms are adequate to stimulate the even stronger interactions that are necessary between those in the university basic science and engineering enterprise and those who work farther along the R&D chain.

Fifth, the proposition that universities now have a serious and growing capital problem is generally accepted, although as seen in the following comment made by one industry round table participant, it is not uniformly understood:

> "This is such a strange problem to somebody in industry. I can't understand that there is a problem, frankly. We have (one of the) largest industrial laboratories in the United States. And the idea of proceeding on any kind of program without having an adequate capital base is unthinkable. We just simply wouldn't do it. Indeed a good deal of our research is government funded, and we don't have any trouble, frankly, getting the capital base, the capital equipment, to do the program work for the government.
>
> I have been in university laboratories and I've seen the decrepit state of the equipment, and I've seen how gracious they are to us when we give them a piece of equipment that is far too old for us to work with anymore. I know what those facts are. I don't know how they got that way. I don't know what this problem is of relationship between universities and the government so that there has arrived this dichotomy between a program and a capital base."

This is the crucial point. Indeed, a wide gap has developed between the policies and programs that support the nation's university research programs and the capital base necessary to sustain those programs and their related training activities. The national commitment, and the policies that flow from it, to invest in fundamental research now are decoupled from the need to provide funds for the renewal of the capital base of the universities.

Sixth, the problems posed by inadequate research instrumentation and instructional equipment penetrate the entire system, from the universities and four-year colleges to two-year vocational schools. Reasoning that obsolete equipment has the most direct and immediate impact on the quality of education they provide to their students today, many institutions have assigned a higher priority to meeting their immediate equipment needs. Simultaneously, equally pressing facilities problems often are left to be addressed later. As a result faculty and students on many campuses continue their work in inadequate laboratories until, in the words of one university participant, "the facilities deteriorate to a desperate condition."

The lack of equipment has immediate and serious adverse consequences, especially for students. This problem should be a cause for national concern for a number of reasons, notably because graduates perform a critical knowledge-transfer function. They are the primary carriers of new knowledge and ideas into industry and government, as well as back into the universities themselves. Some in industry believe that the ability of graduates to perform this knowledge-transfer function has decreased.

Seventh, the capital deficit is a chronic problem; it is not susceptible to a quick fix. Driven by the needs of disciplines now undergoing rapid and accelerating change, the requirement to upgrade instrumentation and rebuild facilities will be constant. As big, costly science spreads across the disciplines, institutions, research programs and their sponsors increasingly feel pressed to meet high acquisition costs as well as the subsequent, frequently greater, costs of installation, operation and maintenance. The proliferation of increasingly powerful and costly computers is the best evidence of this phenomenon.

Eighth, industry can play an important role in helping higher education upgrade its equipment. Therefore, the tax incentives for charitable deductions and for the donation of equipment to universities need to be protected. But relative to the responsibility of the federal government, industry's role will remain limited. (For instance, a full 20 percent increase in industry support will be required to offset a mere one percent decline in federal support. This clearly is unattainable.)

Finally, participants agreed that the dimensions of the capital deficit are insufficiently documented. All interested parties need to know more about the problem and its consequences. Further, all agreed that the role and responsibility of the federal government in this area of data collection and dissemination must be clarified.

J. W. Peltason (University of California, Irvine); Rep. Richard J. Durbin (D-Illinois); and William S. Woodside (American Can Company)

AREAS OF DISAGREEMENT

Some university and industry participants believe that there now is an effective national consensus that federal officials should assign a high priority, and corresponding resources, to modernize research instrumentation and facilities. Members of Congress, they suggest, ought to exert greater leadership to inform their constituents of the priority of enacting the measures needed to address the problem in significant ways. Others, primarily

members of Congress, pointedly disagreed. One House member even suggested that it is time to "defederalize" and "privatize" the university research system.

The chairman of a key House subcommittee now believes that the historical congressional bipartisan consensus that has traditionally sustained the role of the federal government in research has been lost. Further, industry and university leaders have failed to appreciate this new reality. One member of the House Committee on Appropriations explained his perception of the underlying political problem:

> "In spite of the massive influence (of the major research universities in my state), the people out there just don't like what you're all about. That may be brutal news to you. Again, we're out there every two years shaking hands and rubbing elbows and doing polling and asking people what they want. I find in my district, which I regard as pretty enlightened and I love them all, that they think that R&D is a close third behind welfare and foreign aid in popularity. I think it's due in large part to people in the public sector (who feed) the anti-intellectualism of the American people. But unless people out there can sense a tangible benefit and be reminded of it almost daily, such as in the agriculture experiment stations, they think that all this money is going to pointy-headed people to create luxury laboratories for very little work, very little benefit for me, and that's a waste of my tax dollar. . . ."

Robert H. Atwell (American Council on Education)

Others disagreed, arguing that if legislators frame the issue correctly to their constituents, explaining all the benefits they receive from scientific research, then the people will respond. The member replied:

> "It reads well and it sounds nice, but if you ask the Congress to disregard attitudes out there you cannot go a long way (politically). Our opponents do not accuse us of spending money on cancer research. They accuse us of pouring money down that black hole of pointy-headed activity off in some never-never land. I know that I can sit down with a small group of rational people and have the kind of discourse that you're talking about at that level. That is not what's driving the Congress. We have to get the vote of the person who doesn't even want to have the discussion, who's going to be listening to the television ad of your opponent characterizing what you do in the most ridiculous of terms. . . . When you get to a point where an opponent of a member of Congress says, 'That guy's spending money for pointy-headed professors,' and the people say, 'Well, I want him to,' then you've got a victory. We're not there yet."

A broad-based national constituency, some House members insisted, has not been mobilized to support university research, graduate education and the companion capital investments now sought. Before the Congress will act, they said, a stronger national constituency must be mobilized, one that clearly supports a leadership role by the federal government and recognizes the need for new capital investments.

A difference of opinion also emerged concerning the dimensions of the universities' capital deficit. Most university and industry participants agreed that the universities' capital needs require federal government investments in both research equipment and the modernization of research buildings. In one

session, however, two university participants argued that the federal government should focus only on meeting equipment needs. Universities, they insisted, can modernize their buildings without federal assistance. This view was not endorsed by their university colleagues.

OBSTACLES TO ACTION

Daniel Yankelovich spoke of the need to identify the obstacles that must be overcome to form an effective consensus and attain the desired political objective. In addition to the obvious political obstacles identified by the statements reported above, several others emerged during the discussion. Perhaps foremost among them is a loss of faith, expressed by several members of Congress, in the mechanisms now in place to apportion national resources for research and related purposes.

Several legislators expressed growing doubts about the competitive and administrative mechanisms used by funding agencies to allocate research funds. In response, others wondered whether those doubts are spawned because policymakers have forgotten why the universities' research and training roles were linked in the first place. Some legislators believe that the award mechanisms only cause the "rich" institutions to grow richer. The result, they believe, is an excessive concentration and centralization of research resources within a few institutions at the expense of all other colleges and universities.

Similarly, some House members observed that many of their congressional colleagues and the public believe that the vigorous competition among universities for research funds is based solely on the desire for public recognition, and that it defies a rational ordering of national resources. University participants responded by suggesting that the country benefits from competition in all sectors, and that university research is no exception.

Several participants underscored the point that before the nation can agree on the federal government's long-term role in the area of research, a better understanding is needed of the facilities and equipment problem. Not only must the dimensions of the crisis be understood, but so must the consequences of inaction -- to science, to industry, to the universities, to government and to the public.

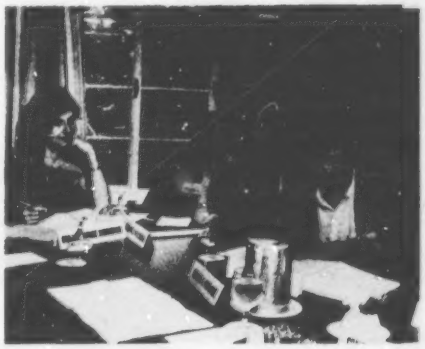
Within that framework, however, several additional obstacles were addressed. Clearly, any definition of the problem must highlight the massive costs of replacing and/or upgrading modern research equipment and facilities; the estimated $30-$40 billion overall nationwide price tag, in itself, could be a formidable obstacle to developing a national consensus for action. Further, some university participants noted that the government's current costing policies must be revised so as to more adequately address the needs of universities and the paramount research requirements of the nation; the participants argued that the current system makes arbitrary, unproductive distinctions among research projects. And during the round table discussions, it appeared that some industry participants harbored mixed feelings about the quality of university research, especially that done to enhance the researcher's public visibility and reputation. Accurate or not, if this perception extends throughout industry, it also could be an obstacle to progress.

ELEMENTS OF AN ACTION PLAN

The discussions suggested directly and implied several possible elements for a plan of action. First, the frankness of these conversations and the differences of opinion revealed herein are sufficient justification for sustaining an ongoing dialogue among industry, university and government representatives on this topic. In itself, the perception of the House members that the traditional bipartisan support for national investment in university research is eroding merits sustained attention by all concerned parties.

There was virtually unanimous agreement among participants that a fresh vision — a long-term look at where the nation is going and of the role of research and graduate education in that process — is needed. This implies that industry and the universities should ask the Executive branch to assert leadership in this area — by articulating that comprehensive vision. At the very least, this new perspective should reaffirm and clarify an appropriate role for the federal government in university research, one that takes responsibility for addressing the needs for research equipment and facilities essential to carry out federally supported research programs.

Role of the Executive Branch — The Executive branch, participants agreed, also needs to project a capital budget as a part of the federal government's overall R&D mission. One suggestion is to require research departments and agencies to address, as part of their own programs, the capital deficit in the disciplines appropriate to their missions. For example, each agency could be required, by new law, to plan and budget for a permanent facilities modernization program funded annually at a level equal to not less than five percent of the agency's R&D program, and to sustain these efforts for an initial period of 10 years. The funds sequestered annually by each agency could be targeted to the modernization needs of university laboratories, which either compete successfully for agency-sponsored research or want to compete for that support. Modernization projects can be funded, on a matching basis, based on the scientific merit of the research to be performed in the facilities, while also taking into account other regional, state and local concerns.



Rep. Claudine Schneider (R-Rhode Island); Rep. William F. Clinger (R-Pennsylvania); and David S. Saxon (The Corporation of the Massachusetts Institute of Technology)

This approach would reconnect the research enterprise of each agency with the capital investments necessary to meet its research objectives. The linkage between each agency's research programs and the capital needs of universities would be reestablished and made an integral part of the R&D mission of each agency. Two other approaches were suggested: establish by law a national commission to formulate recommendations; and create a new agency to address the problem. Each approach contains formidable barriers to action, it was agreed.

The long-term key is to allow the mission agencies to play leading roles; elevating the responsibility of each agency will recognize and build upon the strengths of America's decentralized, flexible and responsive system. As the agencies articulate a renewed vision of their research missions, some industry participants cautioned, they should carefully avoid adopting a "demand-pull" investment philosophy, one that allows near-term mission requirements to drive the design and implementation of research programs. Prior experience indicates that such narrow philosophies can impede long-term research productivity, because "demand-pull" approaches often place counterproductive constraints on researchers and limit vigorous pursuit of new knowledge and ideas.

In developing new approaches, agencies will need to strike a careful balance between the rationality and appealing precision of new mechanisms

and the effective "sloppiness" of proven approaches. One industry participant warned: "The system needs to be steered, but not oversteered."

The government's policy regarding the recovery of indirect costs of federally funded research projects should be revised, too. Office of Management and Budget (OMB) Circular A-21 establishes the principles that govern the recovery of those costs. The present A-21 establishes a use allowance for research equipment and facilities based upon an expected useful life of 15 years for research equipment and 50 years for facilities. Both provisions are generally regarded as outdated and inadequate. They do not recognize the much shorter useful life of equipment and facilities today.

The proposed vision of our future, university participants emphasized, also must specifically address and resolve the arbitrary and diversionary distinctions now plaguing discussions about the costs of research. Within that context, everyone needs to face squarely the true costs of the necessary investments — to government and to the universities themselves.

Howard R. Swearer (Brown University) and James E. Olson (American Telephone and Telegraph Company)

The federal government has a unique opportunity to exercise leadership in mobilizing a national effort to address the capital needs of universities; such an effort is indispensable to the national welfare. Investment in research, facilities and equipment must be clearly identified and embraced as a worthy national objective for at least the next decade.

The Executive branch needs to invite and encourage the states to share in the renewed effort. Industry and the universities also must play active roles. (Individual corporations or their trade associations, one Congressman suggested, might allocate a fraction of their advertising budgets to carry the message to the country that investments in university research, particularly federal investments, are essential to the nation.)

The key is leadership. A vision clearly articulated by the Executive branch will find a responsive Congress, provided legislators are convinced that their constituents will not penalize them at the ballot box for taking a leadership role. Leadership from the White House can help build that necessary consensus.

More also needs to be known about the many dimensions of the problem. Along these lines, the Executive branch should establish a mechanism whereby those interested in the future of fundamental research can know about its capital health in terms independent of its program health. Industry could not function the way universities and their research agencies now do, by divorcing programs from capital requirements. A mechanism to document and assess, on a continuing basis, the capital health of the university research enterprise, by field, is needed in the Executive branch. The system can no longer rely on the sketchy evidence now available or on public opinion to determine the condition of the capital base.

Finally, participants said a sense of urgency is needed. The country cannot wait for another Sputnik before it mobilizes its leadership, opinion makers and the public. The Executive branch and others must recognize and respond to the need now, because the problem is rapidly accelerating to crisis proportions.

ROUND TABLE V: ENGINEERING EDUCATION AND WORKER RETRAINING

Conveners: Wesley W. Posvar, Chancellor, University of Pittsburgh
Representative Claudine Schneider (Republican-Rhode Island)

Resource People: Arden L. Bement, Jr., Vice President-Technical Resources, TRW Inc.
Donald S. Bell, Northeast-Midwest Congressional Coalition
Linda Spencer, Northeast-Midwest Congressional Coalition

THE ISSUE

The United States historically has relied on a highly trained and educated work force as one of its most important advantages in international trade. For the United States to remain competitive in the face of changes now under way in both the national and international economies, worker skills must be maintained and improved at all levels, in older and newer industries, and in both the manufacturing and service sectors. Engineering is particularly important to America's industrial competitiveness because it provides the underpinning for many improved products and processes.

There is evidence that America faces growing challenges in the areas of engineering education and worker retraining, among the fields that constitute the complex system of work force preparation. Despite a 75 percent increase in engineering enrollments and a 103 percent increase in engineering degrees awarded over the past eight years, there are signs that demand still exceeds supply. Similarly, there are concerns about the quality of engineering education. Student-faculty ratios have almost doubled since 1970; recruitment of new engineering faculty has been depressed by a number of factors, which make it difficult for colleges and universities to retain their best teachers.

Although research indicates that 80 percent of those in the work force today still will be working in the year 2000, and it is estimated that up to three percent of U.S. workers need retraining at any one time, the United States has seriously underinvested in the skill development of its workers, compared to other industrialized nations. For instance, in sharp contrast to many foreign countries, the United States devotes 75 percent of its unemployment aid to income support and only 25 support of those funds to reemployment assistance. Among other problems, policymaking is conducted on an ad-hoc basis and adequate labor market information is lacking. The challenges in the areas of engineering education and worker retraining confront industry, higher education and government alike.

GENERAL EDUCATION

Participants agreed unanimously that high-quality general (pre-college) education is a critical prerequisite to success in either advanced engineering, technical training or worker retraining. The point was made several times that if high school students do not take a full complement of math and science courses, the option of engineering or research is eliminated even

before they move on to the college or university level. Similarly, if basic reading and math skills are not acquired early, subsequent retraining efforts will first have to focus on remedial education programs.

Participants felt that the 1983 report *A Nation at Risk* identified the general education problem and accurately reported its fundamental importance to the country. While it was agreed that there are many other organizations better qualified than the Business-Higher Education Forum to address this problem, individual Forum members (and their companies and colleges/universities) could, and should, play leading roles in their communities on this issue. The "Emergency Training in Science and Education" bill passed by the Congress last year provides $450 million for teacher retraining. While this bill represents an important statement of national concern, it only scratches the surface; and Members of Congress at the meeting said they still have an important leadership role to play in their communities in emphasizing the need for improved education.

ENGINEERING EDUCATION

Strong math and science education at the pre-college level is the basic prerequisite for an adequate supply of talent for advanced training. It also is important to expand that labor pool by making more efforts to encourage minorities, women and students from economically depressed areas to pursue careers in technical fields, a point reinforced in an earlier session by Dr. Hodgkinson's demographic data. Part of the problem is that minority and female engineering students do not have many role models. Several participants argued that the Equal Employment Opportunity laws of the 1960s are not working in science and engineering. It was felt that some employers are no longer complying with the intent of that law, and that if Congress were to look below the surface it would find that nearly 80 percent of minority workers employed in science and engineering are Asians.

William O. Baker (Bell Laboratories, retired)

Students — Little concern was expressed about the supply of engineering or technical students beyond the need to expand the potential pool of applicants described above. Current enrollments have increased and the distribution of specialists has responded to perceived job openings and opportunities.

There was, however, a widely shared view that many engineering schools are training students too narrowly instead of providing a broad education. It was felt that many engineering programs are highly vocational and that more emphasis should be placed on education, broadly defined, not just engineering education. Business participants felt that the quantitative skills of newly hired engineers are very good, but that their verbal and interpersonal skills are poorly developed; these deficiencies often prevent graduates from moving into managerial positions after the first few years. It was pointed out that the focus on engineering skills reflects recruiters' priorities, and that chief executives should stress to their recruiters the importance of other abilities. On a positive note, it was mentioned that many college faculties have been developing new programs that emphasize writing and literature.

Equipment and Facilities — While this topic was addressed in separate sessions devoted specifically to the problem (see Round Table IV), it was reinforced in these discussions as well. Participants agreed that engineering undergraduates should do more research. The Massachusetts Institute of Technology, for instance, does a particularly good job of facilitating this

research, but is hampered by a lack of adequate equipment and facilities. It was observed that undergraduate facilities usually are even more outdated than those in graduate programs, and that fewer financial resources generally are available for upgrading them.

Faculty — Participants were very concerned about maintaining an adequate level of engineering faculty — a significant problem at many schools. One proposed solution was to raise the salaries of assistant professors and increase the mobility between academic and business careers for full professors. This approach would pool the available supply of engineering talent and, hence, level out periods of surplus and shortage. Such a solution would encourage more B.S. students to go on for their Ph.D.s and subsequent academic careers, rather than to seek out high industry salaries. Further, it would institute a dual career for engineering professors, replacing the partial split that exists today, whereby academic engineers do some consulting and industry engineers occasionally teach.

It was agreed that raising salaries is important, but the idea of shifting engineers between business and academia raised several concerns. The culture of the two institutions is very different and makes any transition difficult. Many engineers, in both the private and academic sectors, prefer to do research and are not particularly good at teaching. Others prefer the atmosphere of academic freedom and do not like working in a business setting. Businesses have the problem of finishing projects left behind by engineers when they leave to teach. It is very difficult to replace engineers who have been working on long-term projects. The different pay scales also pose a problem. Two-year colleges have found that increased contact between academia and industry helps induce many of their best people to leave teaching for higher salaries in private industry. These people often do not return and are difficult to replace.

All of these problems, participants agreed, underscore the difficulty of general solutions to complex problems. Individual, institution-by-institution solutions often work best.

Rep. Morris K. Udall (D-Arizona)

WORKER RETRAINING

Everyone clearly understood the need to develop ways to retrain workers and improve the skill level of the work force. The fact that the federal government loses $40 billion in revenues for every one percent increase in unemployment reinforced that awareness. Participants also agreed that future training and education initiatives would have to be part of a lifelong process; schools and colleges will no longer be able to turn out people who are fully prepared to perform a single job for their entire careers.

Several participants recommended integrating work and education, with training part of the job description. For instance, some countries in Europe require five hours of education for every 40 hours worked. This linkage of work and education could occur in the work place through new kinds of technology. This approach would play to a strength in retraining: people are much more responsive to training when they perceive that it helps them do their job better or leads to new and *existing* job opportunities.

While unanimous support was expressed for a better-educated and more highly skilled work force, some business leaders were concerned about raising workers' expectations and not being able to satisfy them. A subsequent concern was raised over forecasting: the difficulty of predicting future jobs and skill requirements. One suggestion was to use general retraining programs to

provide generic computer, reading and analytical skills and let business provide specific training for jobs after the individuals are hired. This approach would avoid the problem of general retraining programs becoming too specific, raising expectations for jobs that do not become available. It also would address the problem now plaguing many programs and institutions: many workers need remedial education to benefit from retraining.

Ronald W. Roskens (University of Nebraska) and Matina S. Horner (Radcliffe College)

One concern was that businesses do not consider training or retraining as an alternative to lay-offs. Companies must have their awareness raised and be encouraged to choose training and retraining as a positive, long-term option. In this respect, the United States — with its "throw-away" ethic — is behind the rest of the world. Members of Congress re-emphasized the need for training and the common interest of all groups in facilitating it. For instance, when companies let workers go, especially without warning, legislators are more inclined to enact plant-closing legislation. Business leaders who disapprove of such legislation could help avoid it by encouraging each other to provide retraining as an option.

Another explanation of why support for retraining is not widespread is that workers — the parties with the most to gain — become interested only when disaster strikes in the form of unemployment. It was felt that retraining options would succeed only if they were received as an insurance policy, not a first alternative.

In discussing long-term solutions to retraining, participants returned to the need for education. Specific training in technical skills is not as important as general education, according to the information given by Dr. Hodgkinson in an earlier session. If only one million of the 21 million new jobs created are technical, such training will not meet the needs of either society or individuals. Business executives agreed and gave examples of how their companies are moving away from the manufacturing/production sector and into the service sector.

A consensus existed that community colleges are the academic institutions best positioned to respond to retraining needs. They are flexible enough to respond to local requirements and have more experience retraining older students. Many successful examples were offered of how states and companies had worked together through community colleges to prepare a new work force. It was felt, however, that four-year colleges and universities also should play a role and be involved in cooperative arrangements with both business and community colleges.

The question of financing these retraining efforts was considered against the backdrop of the federal government's severe budget deficit. Large corporations can, and do, finance some efforts on their own. Several companies represented at the meeting are leaders in this area. Smaller companies, however, have a tougher time. In this context, the related concepts of Individual Training Accounts and using Individual Retirement Accounts for retraining were advanced. These ideas drew a great deal of interest, and general support was expressed for this type of approach.

OBSTACLES TO CHANGE

Finally, the difficulty of changing institutions was the subject of extensive discussion in one session. Corporate chief executive officers felt they could change attitudes only slowly, while university presidents felt limited by certification requirements and entrenched attitudes in particular academic disciplines. No solutions were offered, only explanations of the difficulty in making widespread changes.

HODGKINSON WARNS ABOUT IMPACT OF CHANGING DEMOGRAPHIC TRENDS

Major changes are coming soon in the racial makeup of the U.S. population and in the types of available jobs, but few, if any, segments of American society are ready for them, Harold L. Hodgkinson, Senior Fellow at The Institute for Educational Leadership, warned Forum members at the Friday breakfast meeting.

Prominent among those changes is a major shift in the ethnic composition of the United States, which is now made up of a developed population (white) and a developing population (non-white). Since 1964, the white birth rate has been declining, while the birth rate for blacks and Hispanics has been increasing. As a result, the average age of U.S. whites is 31, of blacks, 25 and of Hispanics, 22. Today, more than 27 percent of public school students are minorities and that percentage is growing rapidly.

If, as expected, technology continues to eliminate traditional mid-level "middle-class" jobs, the vast majority of these future minority graduates will be stuck in low-level service and clerical occupations, the types of jobs their parents held with only third-grade educations. Such a bleak future is hardly "designed to create feelings of loyalty, patriotism or well-being" among those denied the upwardly mobile fruits of the traditional American dream, Hodgkinson observed.

There are several other significant demographic trends that will have a major impact on both education and business, Dr. Hodgkinson predicted:

- The college population is changing. By 1992, half of all college students will be 25 and one in five will be 35 years old or older, meaning that higher education must target programs at this older market of students, many of whom are returning to school from the work force.
- The dual-earner couple is the new upper-middle class. In 1955, 60 percent of all U.S. households consisted of a working father, stay-at-home mother and two school-aged children. That family now makes up only 11 percent of U.S. households, while fully 21 million Americans live alone and 50 percent of mothers of one-year-olds are back at work.
- America is aging. There are now 2.2 million Americans over 85, 30,000 of them over 100. In addition, 60 million Americans will retire between the years 2000 and 2020.

Art Buchwald and James H. Zumberge (University of Southern California)

PREVIEW OF RECOMMENDATIONS FROM THE PRESIDENT'S COMMISSION ON INDUSTRIAL COMPETITIVENESS

The Forum, whose own 1983 report helped precipitate formation of the Presidential panel, received a detailed preview of the Commission's report, which was released in mid February.

Past Forum Chairman Robert Anderson (Chairman and CEO, Rockwell International Corporation) introduced the panel session by pointing to the Commission's ability to achieve "a remarkable consensus drawn from a very diverse group about the severity and the causes of the competitiveness issue, as well as some specific actions and policy directions that hopefully will address them." Anderson then turned the session over to three Commission

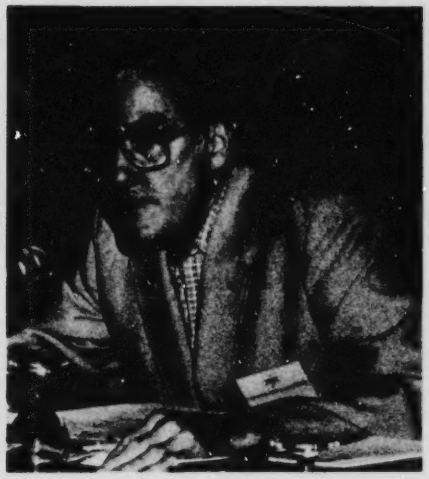
colleagues, who addressed the panel's recommendations in the key areas of R&D and manufacturing, capital resources, human resources and international trade.

Forum member Gerald D. Laubach (President, Pfizer Inc.) said the principal recommendation in the R&D and manufacturing area called for the establishment of a Cabinet-level Department of Science and Technology to consolidate all the non-defense-related R&D activities of the federal government. Among other benefits, the new department could help streamline the allocation of R&D resources and underscore the importance of science and technology to the nation's economic well-being.

In the area of capital resources, the Commission had four top priorities, according to Robert Baldwin (Chairman, Advisory Board of Morgan Stanley, Inc.), all geared to encouraging Americans to invest more capital in productive enterprises. "Despite being the world's richest nation, we simply do not produce an adequate supply of funds for productive investment," Baldwin said, before outlining the Commission's basic recommendations: reduce the federal deficit; restructure the tax system; pursue a stable monetary policy; and minimize government intervention into the free flow of capital.

Thomas J. Murrin (President, Energy and Advanced Technology Group, Westinghouse Electric Corporation) bypassed human resource issues that had been addressed elsewhere by Forum members in Scottsdale — such as engineering education, retraining, business schools and improved labor-management cooperation — and instead focused on several other key issues of Commission concern. Among its dozens of specific recommendations, the Commission: 1) endorsed the cities-in-schools and adopt-a-school approaches as a means of reducing student drop-out rates; 2) urged early identification of workers who will be displaced by technology; 3) urged employers to "put in place incentive systems that reinforce the work ethic and give employees a greater stake in the outcome of the enterprise"; and 4) called for increased dialogue among business, academic, government and labor leaders, such as that fostered by the Forum.

Finally, Harry Strachan (Partner, Bain & Company) discussed growing protectionism in response to increased global competition and outlined the Commission's basic recommendations in the area of trade: strengthen the multilateral system for negotiations; and integrate and streamline America's own trade policymaking and enforcement processes.



Richard B. Madden (Potlatch Corporation)

J. W. Peltason (University of California, Irvine); Admiral Bobby Inman (Microelectronics and Computer Corporation); Thornton F. Bradshaw (RCA Corporation)

UPDATE ON FORUM'S BUSINESS SCHOOL REPORT

In a discussion led by Advisory Committee Co-Chairmen Richard B. Madden (Chairman and CEO, Potlatch Corporation) and Harold T. Shapiro (President, The University of Michigan), Forum members received a preview of the upcoming report on America's business schools. In opening the discussion, Shapiro observed the report's objectives are "not to revolutionize business education," but to stimulate a dialogue on the current quality and appropriateness of business education. The report will focus on university-based business schools and will emphasize the need for program diversity among schools and a recognition that formal business education is only a single component of the lifelong learning process.

The discussion centered on such topics as the problem of attracting and retaining high-quality faculty and the need for business schools to increase their teaching of such subjects as the humanities, international studies and

entrepreneurship. Further, the sensitivity of business schools to the special needs of women and minorities was questioned.

The report was published and widely disseminated in May.

UPDATE ON FORUM'S EXPORT CONTROLS REPORT

Robert Rosenzweig (President, Association of American Universities) reported that his Advisory Committee on Export Controls had been unavoidably delayed in submitting a draft report by a steady stream of last-minute Administration policy changes governing the export of U.S. technology. "Anything we might have set down on paper as recently as six weeks ago would largely have been rendered obsolete by developments in this extraordinarily fluid and uncertain area of public policy," Rosenzweig said. Among the more significant developments: further clarification of the respective roles of the Commerce and Defense Departments in granting export licenses; and a revised policy distinguishing between classified and unclassified scientific communications.

The Advisory Committee intends to prepare a draft report reflecting ongoing developments, in time for the June Forum meeting at the University of Notre Dame.

Mr. and Mrs. Clifton R. Wharton, Jr. and Mr. and Mrs. Harold T. Shapiro

PARTICIPANTS

Among those participating in the 1985 Winter Meeting of the Business-Higher Education Forum were:

Robert Anderson
Chairman of the Board and Chief Executive Officer
Rockwell International Corporation

Robert H. Atwell
President
American Council on Education

Hon. Bruce Babbitt
Governor of Arizona

William O. Baker
Chairman-Retired
Bell Laboratories

Robert H. Baldwin
Chairman, Advisory Board
Morgan Stanley, Inc.

Thomas A. Bartlett
Chancellor
The University of Alabama System

Rep. Berkley Bedell
Democrat-Iowa

James Beggs
Administrator
National Aeronautics and Space Administration

Rep. Sherwood L. Boehlert
Republican-New York

Albert Bowers
Chairman and Chief Executive Officer
Syntex Corporation

Thornton F. Bradshaw
Chairman of the Board and Chief Executive Officer
RCA Corporation

Art Buchwald
Humorist

John F. Burlingame
Vice Chairman
General Electric Company

Philip Caldwell
Chairman
Ford Motor Company

Rep. Bob Carr
Democrat-Michigan

Gene S. Cesari
President
Cedar Crest College

Rep. William F. Clinger, Jr.
Republican-Pennsylvania

Rep. William J. Coyne
Democrat-Pennsylvania

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Rep. Robert W. Edgar
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The University of North Carolina

Rep. Don Fuqua
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Rev. Theodore M. Hesburgh, C.S.C.
President
University of Notre Dame

Harold L. Hodgkinson
Senior Fellow
Institute for Educational Leadership

Matina S. Horner
President
Radcliffe College

Admiral Bobby Inman
Chairman
Microelectronics and Computer Corporation

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Metropolitan State University

George D. Langdon, Jr.
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Colgate University

Gerald D. Laubach
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Rep. Buddy MacKay
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President
Saint Joseph's University

Richard B. Madden
Chairman and Chief Executive Officer
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University of Pittsburgh

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George A. Robert
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Association of American Universities

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Rep. Martin Olav Sabo
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James H. Zumberge
President
University of Southern California

ABOUT THE BUSINESS-HIGHER EDUCATION FORUM

The Business-Higher Education Forum was created for the express purpose of promoting discourse and acting on issues shared jointly by American business and the nation's higher education institutions.

Founded in 1978, in affiliation with the American Council on Education, the Forum is an organization of leading corporate and academic chief executives. The Forum's major objective is to provide an opportunity for interchange among its members on matters pertaining to their respective interests and, hence, to the common aspirations and needs of the business and academic communities. Within that framework, the Forum has three major goals:

- to identify, review and act on selected issues and topics that relate to the current and future requirements of business and higher education;
- to enhance public awareness of the concerns shared by business and academic leaders and to serve as a positive contributor in helping shape public policy thinking as it affects those concerns; and
- to help guide the evolution of future relationships between corporate America and institutions of higher learning, while preserving their separate historical and traditional functions.

Social and economic progress in the United States owes much to the vital contributions business and higher education have made to each other — and to the larger society. Today, prosperity in both sectors faces unprecedented chalienges. But there are also unlimited opportunities. The Forum is a unique expression of the leadership and thinking so essential to continuing and achieving that quest.

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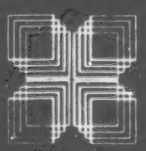

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